STRAWBERRY MANSION BRIDGE
(Fairmount Park Trolley Bridge)
Pennsylvania Historic Bridges Recording Project - II
Spanning Schuylkill River at Strawberry Dr.
Philadelphia
Philadelphia County
Pennsylvania

HAER No. PA-92

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HISTORIC AMERICAN ENGINEERING RECORD
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Location:	Spanning Schuylkill River at Strawberry Dr., Philadelphia, Philadelphia County, Pennsylvania.
USGS Quadrangle:	Philadelphia, Pennsylvania-New Jersey (7.5-minute series, 1994).
UTM Coordinates:	18/483460/4427010
Dates of Construction:	1896-97.
Designers:	Russell M. Thayer, Chief Engineer, Fairmount Park Transportation Company; Theodore Cooper, consulting engineer.
Fabricator / Builder:	Phoenix Bridge Company (Phoenixville, Pennsylvania).
Present Owner:	City of Philadelphia.
Present Use:	Vehicular and pedestrian bridge, closed for rehabilitation.
Significance:	The Strawberry Mansion Bridge crosses the Schuylkill River in Fairmount Park, a National Register-listed historic district. The bridge is significant for its construction under private ownership by the Fairmount Park Transportation Company, a streetcar line operating in the park. Nationally recognized bridge engineer Theodore Cooper consulted on the design of this spandrel-braced, three-hinged steel arch structure, which set records within its type for overall length and speed of erection. It is also a major work of the Phoenix Bridge Company, a prolific fabricating and erecting firm.
Historians:	Helen P. Ross, August 1998. Revised and expanded by Justin M. Spivey, March 2001.
Project Description:	The Pennsylvania Historic Bridges Recording Project II was co-sponsored during the summer of 1998 by HABS/HAER under the general direction of E. Blaine Cliver, Chief; the Pennsylvania Department of Transportation, Bureau of Environmental Quality, Wayne W. Kober, Director; and the Pennsylvania Historical and

Museum Commission, Brent D. Glass, Executive Director and State Historic Preservation Officer. The fieldwork, measured drawings, historical reports and photographs were prepared under the direction of Eric DeLony, Chief of HAER.

Introduction

Spanning the Schuylkill River in Philadelphia's Fairmount Park, the Strawberry Mansion Bridge is a significant example of a spandrel-braced, three-hinged steel arch bridge. It carries a park road currently known as Strawberry Drive, linking Ridge Avenue to the east with Ford Road to the west. The structure set a record among arch bridges for overall length at the time of its construction, which proceeded at a notably rapid pace. Theodore Cooper, a nationally recognized bridge engineer, consulted on the design, which was fabricated and erected by Phoenixville, Pennsylvania-based Phoenix Bridge Company in 1896 and 1897. The bridge is also significant for its association with the Fairmount Park Transportation Company, a streetcar line that owned the structure until 1933 and continued to maintain a private right-of-way across it until 1946. Whether by streetcar, bus, car, or foot, generations of Philadelphians and visitors have crossed the Strawberry Mansion Bridge to enjoy the amenities of Fairmount Park.

In the 1890s, Fairmount Park was the world's largest urban park. From five acres surrounding the Fairmount Water Works in 1812, the park was expanded to more than 4,000 acres, including land formerly occupied by some of the city's wealthiest residents. Among the large private residences acquired by the park is Strawberry Mansion, built 1797-98, from which the bridge takes its name. The park also contains fourteen miles of tributaries and the Schuylkill itself, which formerly provided water power for a variety of enterprises. The earliest industries were mills in the Wissahickon Creek valley, with Richard Townsend operating a grist mill as early as 1686. Not until after the end of the Civil War was the west bank of the Schuylkill included in the park. Following the U.S. Centennial Exposition of 1876, the park matured into a picturesque combination of landscaped parkland and natural areas. The Exposition drew thousands of visitors to West Fairmount Park, a massive array of buildings and landscaped grounds. Celebrating a century of U.S. history and demonstrating futuristic applications of technology, the Exposition was an instant hit with the city and the world. In the wake of the event, the park became a year-round destination for refuge-seeking locals and day trippers. Private ventures and various city agencies scurried to improve the urban infrastructure as West Philadelphia opened up for development. During the closing decades of the nineteenth century, modern iron and steel spans such as the Girard Avenue Bridge (1874), Falls Bridge (1895), and Strawberry Mansion Bridge (1897) were built to ensure reliable and safe access to West Fairmount Park and beyond.[1]

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[1] John Bowie, ed., *Workshop of the World: A Selective Guide to the Industrial Archeology of Philadelphia* (Wallingford, Pa.: Oliver Evans Press, 1990), 11-3 through 11-6; George B. Tatum, "Fairmount Park," Philadelphia

The Fairmount Park Transportation Company

The Strawberry Mansion Bridge was built by the Fairmount Park Transportation Company, a privately owned streetcar line, in exchange for a concession to operate in the park. Prior to the bridge's construction, there was no Schuylkill River crossing between Girard Avenue and the Falls Bridge, and therefore no direct route between the two halves of the park. The idea of another bridge was first proposed to the Fairmount Park Commission in the 1880s, in conjunction with plans for a gravity railroad in the west park. A license was issued to a railroad equipment manufacturer, William Wharton, Jr., but plans did not materialize due to lack of funding. The proposal emerged again in 1894, backed by a new group of promoters headed by Charles A. Porter, then at the height of his influence in city politics, along with David Martin and David H. Lane. Calling themselves the Fairmount Park Transportation Company, they agreed to provide an ornamental iron bridge over the Schuylkill accommodating all modes of travel, including the new company's streetcars.[2]

The Fairmount Park Transportation Company operated for half a century as the country's only streetcar line entirely within a public park. After an initial period of financial success, the company experienced financial problems alternating with modest gains. Combined with the seasonal nature of operations, however, slim profits meant that its streetcars and infrastructure received little maintenance. By 1933, the Strawberry Mansion Bridge suffered from old age and corrosion, with the company claiming that it had insufficient funds for repairs. The city took possession of the bridge and used a Public Works Administration grant to renew the deck. On 9 September 1946, the Philadelphia Transportation Company's No. 85 bus route replaced the streetcar service.[3] The tracks and ties were removed in 1947, leaving bare floor beams in the company's right-of-way on the bridge.

Designers and Builders

The Fairmount Park Commission's Chief Engineer, Russell M. Thayer, can be credited with initiating the bridge's design and soliciting proposals from a number of leading bridge-building companies in May 1895. He also served as the Fairmount Park Transportation Company's Chief Engineer, causing some accusations of conflict of interest when the bids came in. "His dual position," as newspapers called it, was not uncommon for prominent Philadelphia

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County, Pennsylvania, National Register of Historic Places Registration Form, 1972, Section 7, p. 1, U.S. Department of the Interior, National Park Service, Washington, D.C.; Richard J. Webster, *Philadelphia Preserved: Catalog of the Historic American Buildings Survey* (Philadelphia: Temple Univ. Press, 1976), 225.

[2] "Men And Things," *Evening Bulletin* (Philadelphia), 22 Apr. 1933.

[3] Harold E. Cox, *The Fairmount Park Trolley: A Unique Philadelphia Experiment* (Forty Fort, Pa.: self-published, 1970), 29-31; "Inspection of the Various Road-Improvement and Bridge Projects," *Evening Public Ledger* (Philadelphia), 1 Sep. 1934; "Repaired Bridge in Park Reopened," *Evening Public Ledger* (Philadelphia), 14 Sep. 1934.

engineers of the time, however. Alexander J. Cassatt, President of the Pennsylvania Railroad, and George S. Webster, Chief Engineer of the Philadelphia Department of Public Works, were also park commissioners. Thayer, born in Philadelphia on 24 December 1852, received his engineering degree from the U.S. Military Academy at West Point, New York, in 1874. For some time he was employed as an engineer for the Pennsylvania Railroad. Throughout his life he retained his military ties, serving in the National Guard and eventually achieving the rank of Brigadier General. He was Fairmount Park's chief engineer for twenty-three years and resigned in 1898 to preside over private utility companies.[4]

Thayer had specified a bridge with three main arches, but the Phoenix Bridge Company submitted the lowest of four bids, offering to build a four-arch bridge using thinner steel members for $200,000. Phoenix was one of a number of bridge fabricating and erecting companies that advertised its products in U.S. and foreign markets during the late nineteenth century. Their prolific output allowed railroad, streetcar, and road networks to expand dramatically. Phoenix Bridge capitalized on the patented "Phoenix Column" compression member in standardized short spans, but also constructed custom designs of much greater length. Having erected the Girard Avenue Bridge in 1874 and with its corporate offices at 410 Walnut Street, the company was no stranger to Philadelphia. According to the *Evening Bulletin,* Phoenix Bridge had "the edge on city bridge building." In June 1896, Phoenix Bridge was awarded the contract for what Thayer believed "would be one of the handsomest bridges in the country."[5]

Phoenix Bridge had beaten their closest competitor, A. and P. Roberts, agents for Philadelphia-based Pencoyd Iron Works, by $29,000. Phoenix Bridge's alternate design used steel 1/16" thinner than in Thayer's design by substituting four 208'-0" arches for his three 278'-0" spans. When Phoenix Bridge was awarded the contract, the Pencoyd agents pointed out that the 5/16"-thick steel members fell below the 3/8" minimum in Thayer's specifications.[6] The Fairmount Park Commission called in a New York-based consultant, Theodore Cooper, to examine Phoenix Bridge's design. He made a number of suggestions for its improvement but otherwise endorsed the design, ensuring that the contract went to Phoenix Bridge.[7]

Having finessed the design and continuing to serve as a consultant throughout the project, Cooper deserves credit alongside Thayer for the Strawberry Mansion Bridge. Born on 13 January 1839 in Cooper's Plain, New York, Cooper was a graduate of the Rennselaer Polytechnic Institute. He exemplified a new generation of civil engineers and soared to the top of his profession. Through the 1860s and 1870s he worked on countless railroad and bridge projects for employers as diverse as the U.S. Navy and the Keystone Bridge Company. By 1879,

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[4] Lewis R. Hamersly, ed., *Who's Who in Pennsylvania,* 1st ed (New York: L. R. Hamersly, 1904), 735.

[5] "His Dual Position," *Evening Bulletin* (Philadelphia), 15 Jul. 1896.

[6] "The Design and Specifications for the Fairmount Park Bridge," *Engineering News* 36, No. 7 (13 Aug. 1896): 109.

[7] "Park Bridge to Be Changed," *Evening Bulletin* (Philadelphia), 7 Aug. 1896.

Cooper had established a consulting practice in New York City and was later involved in projects such as the New York Public Library and the city's subway system. He retired from his practice in 1907, not long after consulting on the first Quebec Bridge, which collapsed during construction. He died in 1919.[8]

Construction

Construction of the Fairmount Park Transportation Company's street railway tracks coincided with the bridge, both beginning in early summer 1896. In West Fairmount Park, roadbed leveling and track laying proceeded steadily while work crews excavated the bridge's pier and abutment foundations. Throughout the fall, stonemasons hurriedly laid tons of massive blocks of Germantown granite. Wooden falsework was built in the shallow river during the winter months. In early spring of 1897, the spans were readied for erection.

The Strawberry Mansion Bridge is significant for its departure from the conventional construction sequence. Rather than erect the chords and spandrel bracing one panel at a time, the arches' lower chords were first completed in their entirety. Once the lower chord members had been connected to form a complete arch, the web members and upper chords were installed panel by panel. This minimized the shifting of loads on the falsework during erection, and speeded the process considerably. Three of the main spans were completed, including the roadway and streetcar tracks, in one month. The entire structure was completed and opened to streetcar traffic on 13 June 1897. Crowds flocked to the park's Elm Avenue and Dauphin Street entrances to board streetcars for the ride across the bridge.[9]

Description

The Strawberry Mansion Bridge is significant as an exceptionally large example of a metal arch bridge. The arch form is not only aesthetically pleasing, but also accommodates a variety of erection methods. In the nineteenth and early twentieth centuries, however, metal arches were far less common than truss designs among U.S. bridges. One important reason for this was the challenge of designing an arch's curved members. Stress distribution on the arch varies with the number of hinges and where they are located. Arch structures are categorized as fixed, single-hinged, two-hinged, or three-hinged. Hinges provide a release for bending stresses caused by temperature variations or foundation settlements, and simplify design calculations. In the case of a three-hinged arch, there are hinged bearings at either abutment, and a third hinge at

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[8] For additional reading on Cooper's life, see Henry Petroski, *Engineers of Dreams: Great Bridge Builders and the Spanning of America* (New York: Alfred A. Knopf, 1995), chapter 3; and American Society of Civil Engineers, *A Biographical Dictionary of American Civil Engineers* (New York: American Society of Civil Engineers, 1972), 26-27.

[9] "The Fairmount Park Arch Bridge," *Engineering News* 40, No. 5 (4 Aug. 1898): 68; see also newspaper clipping files, Fairmount Park Commission Archives, Philadelphia, Pa.

the arch's crown, allowing the arch to settle unevenly without distorting its two halves. Major fabricators such as the Phoenix Bridge Company were fully capable of manufacturing custom spandrels, girders, and hinge assemblies for arch designs in addition to more ordinary truss parts.[10]

The Strawberry Mansion Bridge's total length is 1,237'-0", including four spandrel-braced, three-hinged steel arch spans over the river. With the exception of the railings, the entire bridge is constructed of medium steel and weighs approximately 2,666 tons. Each of the four arches is 200'-0" long, measured from center to center of its hinges. The arches are seated in cast-steel pedestals on each pier, with a spacing of 8'-0" between the hinges of adjacent spans, hence the 208'-0" figure commonly cited as the span length. Granite blocks from a Germantown quarry were used in the abutments and piers supporting the arch spans. The river spans are flanked on either end by three Warren deck truss approach spans: two 70'-0" and one 85'-0" long on the east; two 70'-0" and one 40'-0" long on the west. These trusses are approximately 6'-0" deep and are carried on slender columns with cross bracing.[11]

All of the arches have the same springing line, and are 6'-0" deep between upper and lower chords at the crown. The deck has an uphill grade from west to east across the entire bridge, 2.56 percent on either approach, with a gentler grade of 1.20 percent on the arch spans. Because of the grade, none of the arches is symmetrical or of the same vertical dimensions as the others. The westernmost arch rises 40'-0" from springing to crown, while the easternmost arch rises 47'-6". Nonetheless, all spans have the identical member sizes. Each span has three arch ribs on 28'-0" centers, and is divided into twelve 16'-8" panels by the spandrel bracing. The web and chord connections are riveted, with pins found only at the three hinge locations. The crown hinge pin is 12" in diameter, while the skewback hinge pins are 10". The upper chords are laterally braced by the floor system, whereas a system of cross-bracing ties the ribs together in the plane of the lower chord. There is additional cross-bracing in the transverse vertical plane of each panel, supporting plate-girder floor beams 36" deep. The floor beams rest atop the upper chords and cantilever outward 12'-0" to either side.[12]

The bridge originally carried three modes of transportation on its 80'-0"-wide deck. These included a 12'-0" pedestrian walk on the north (upstream) side, a 40'-0" wide roadway in the middle, and two streetcar tracks on the south side. Unlike other streetcar lines with tracks down the middle of city-owned streets and bridges, the Fairmount Park Transportation Company had a private right-of-way. This right-of-way included a 28'-0"-wide strip on the Strawberry

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[10] Donald C. Jackson, *Great American Bridges and Dams* (Washington, D. C.: Preservation Press, 1988), 33; Mario Salvadori and Robert Heller, *Structure in Architecture: The Building of Buildings,* 3rd. ed (Englewood Cliffs, N.J.: Prentice-Hall, 1986), 204.

[11] "The Fairmount Park Arch Bridge," 67.

[12] "The Fairmount Park Arch Bridge," 67.

Mansion Bridge, with a fence between the tracks and the roadway.[13] The bridge therefore had not two, but three lines of ornamental wrought-iron railing. The outside railings have 11'-0"-wide cast-iron pilasters over the piers between arch spans. The pilasters do not appear in early drawings of the bridge, but a plan dated 2 March 1897 shows the railings as built. The plan also shows six wrought-iron rosettes filling the tall vertical space between pier and deck, but this feature does not appear in early photographs of the bridge and was probably never installed.[14] At intervals along the span, ten ornamental portals supported overhead wires for the streetcar; these have since been removed.

The deck has been the most frequently altered feature of the Strawberry Mansion Bridge. In its original configuration, the sidewalk and roadway were supported by buckle plates carried on longitudinal stringers 4'-0" on center, filled with bituminous concrete, and topped with an asphalt wearing surface. Except for built-up sections under the railings, the stringers were rolled I-beams, 10-1/2" deep and weighing 76.5 pounds per foot under the sidewalk, 12" deep and weighing 120 pounds per foot under the roadway, and seated in cast-iron chairs. The streetcar tracks were supported by 6" x 6" wooden ties laid across rolled I-beam stringers, 12" deep, 120 pounds per foot, and placed 6'-0" on center.[15] During the 1934 renovation, the deck was removed to replace deteriorated floor beams. The structure was re-decked again in 1960 with steel plates on a structural grid. On 22 May 1996, the bridge was closed to all traffic in order to rehabilitate the deck once more.[16]

Conclusion

The Strawberry Mansion Bridge is an important example of a late nineteenth-century metal arch bridge, designed by a well-known bridge engineer and built by one of the period's leading bridge manufacturers. It is also significant for carrying the country's only streetcar line operating entirely within a public park. When completed, the bridge was the longest such structure ever built with all four arches having different dimensions. The Phoenix Bridge Company not only fabricated the components for this complicated design, but also devised a rapid method of erection. Despite a lack of maintenance during its initial years of private ownership, the bridges' structure, except for its deck, remains intact.

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[13] Cox, *The Fairmount Park Trolley,* 9.

[14] "Fascia, Cornice and Pier, Fairmount Park Bridge," 2 Mar. 1897, Fairmount Park Commission Archives, Philadelphia, Pa.

[15] Frank W. Skinner, *Types and Details of Bridge Construction,* vol. 1, *Arch Spans* (New York: McGraw-Hill, 1904), 34-35.

[16] James D. Leasure, memorandum to James W. McPhillips, 21 Mar. 1985, in bridge inspection files, City of Philadelphia, Department of Streets, Highway Division, Bridge Maintenance Unit; "Historic Span to Get Rehab," *Philadelphia Daily News,* 23 May 1996, 9.

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